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The Defence Science and Technology Organisation (DSTO) is part of the Department of Defence and provides scientific advice and support to the Australian Defence Organisation. DSTO is headed by the Australian Chief Defence Scientist, Dr Roger Lough, and employs about 2100 staff, including some 1300 researchers and engineers. It is one of the two largest research and development organisations in Australia.

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Giving longer life to **T56 engines**

An international group of research partners is carrying out fatigue testing on the turbine section of Rolls-Royce T56 engines to extend the declared safe operating lives of this component beyond previously accepted limits.

T56 engines are in operation on Australian Defence Force aircraft on the C-130 transport aircraft and the P-3C maritime patrol aircraft.

The project, managed by Rolls-Royce, includes the research organisations NRC Canada, CSIR South Africa and US NAVAIR in addition to DSTO.

DSTO and NRC Canada are carrying out spin testing of T56 turbine discs and spacers to establish the point of onset of metal fatigue.

Each spin test cycle subjects the T56 turbine hardware to the same stress range experienced during a flight, simulating the actual usage of the component. The turbine parts are then periodically inspected for cracks in the highest stressed critical locations.

Under heat and stress

DSTO researcher Bryon Wicks explains, "The turbine operates at high speed and high temperature to develop the power to drive the aircraft's propellers. Since the failure of a critical high energy turbine rotor part can have catastrophic consequences for the engine and aircraft, the life of these parts is closely controlled."

"At the same time," he says, "to foreshorten the lives of these components unnecessarily means that we also increase maintenance costs and reduce engine availability unnecessarily."

The test facility was designed and manufactured at DSTO Fishermans Bend, building on existing expertise to conduct the tests, carry out inspections of the test articles and analyse the results.

The cyclic testing rate has been progressively improved and the facility is now capable of continuous operation on a weekly 24-hour basis.

DSTO personnel with T56 spin test apparatus

Spin cycle targets

A major milestone was achieved with 30,000 spin test cycles accrued on a Stage 3 turbine disc.

From the information gained, Rolls-Royce is considering extending the lives of T56 Series III turbine discs in service worldwide from 12,000 cycles to 16,230 cycles, once the same target is reached for the Stage 2 turbine discs being tested at NRC Canada.

"This is a 'first' for an engine manufacturer to extend the lives of critical parts as a result of independent test and analysis," says Wicks.

The next phase of testing has commenced, with a further 20,000 cycles run with flaws inserted in critical locations to deliberately start and grow cracks in order to validate crack propagation life models and to provide further information on technical airworthiness.

From an Australian perspective, the collaboration has been highly successful; leading to development of a productive relationship between DSTO and an engine manufacturer, providing access to data not otherwise available, and enabling DSTO to provide better advice for managing the RAAF T56 engine fleet.

Unlocking the mind of Hercules

The Hercules C-130J was created with deep-sighted powers of intelligence, like those of its godly namesake, but, as DSTO discovered, these strengths were not being applied to the functions of propeller balancing and engine operations.

Graham Forsyth and Brian Rebbechi.

DSTO researcher Brian Rebbechi explains, "The modern Hercules C-130J, acquired by the RAAF in 1999, is a software-driven aircraft with a mission computer, a central 'brain' that controls and monitors every function of the aircraft from checking if the rear door is closed through to keeping tabs on whether the engines are operating correctly."

"We found an advanced engine monitoring capability that was active but wasn't being used," he says, "and to access this required no modification or change to aircraft hardware or software – only a tool to extract and decode data from a data bank recorded during every flight."

The first application of this potential has been to access a latent on-board propeller balance capability.

Current procedure for all C-130J users is to temporarily install vibration sensors and wiring to each power plant, tow the aircraft to an engine run-up area, carry out vibration checks and balance if required, then after completion, return the aircraft to the flight line, remove temporary wiring, and return to service. This process takes around a full day, requiring two shifts with at least four people per shift.

Towards mission computer assisted propeller balancing

DSTO's research into propeller balancing began in 2003 when Rebbechi inquired into why the existing C-130J on-board vibration monitoring system wasn't being used for this purpose. There seemed to be no convincing reason. The RAAF offered him support for limited ground testing of the system. He took the results of this work to Sydney in April 2003 to present to the C-130J Joint Users Group.

There he was given a keen but cautious response, with Lockheed Martin Aeronautics (LM Aero) inviting him to visit its plant in Marietta, Georgia in the United States, to further discuss the proposal with its propulsion people. During this visit, Rebbechi established the basic balance principles and algorithms involved, and explained the success of earlier testing on RAAF aircraft.

The appraisal by LM Aero was that 'it would probably work, but needed flight testing'.

The RAAF and DSTO then proceeded to a flight test program in December 2003. With the participation of a US Navy test pilot from Pax River Naval Air Station, and with LM Aero representatives looking on, a ten-hour test program was undertaken and proved the validity of the methodology. A final trial was carried out in May 2004 on two operational aircraft, confirming in-service effectiveness.

A major advance in C-130J capability

The trials showed that all of the required balance data could be derived from a single 'event marker' button push on the aircraft, and the data could be interrogated with a solution computed just a few minutes after landing. The correction process involved a simple procedure of making the appropriate weight changes at the propeller hub, with no ground running necessary.

These developments allow for a dramatic improvement in capability and availability since the procedure can be undertaken with no disruption to aircraft operations. During the May 2004 trial demonstration, an aircraft used for the trial balance procedure completed two regular operational sorties that day, with the weight changes made during aircraft turnaround.

This new approach to propeller balancing is far superior to previous methods that require a full day when the aircraft is not available for operational use. The acquisition of a balance solution in-flight will also mean lower vibration levels, and aircraft balance only undertaken as and when necessary.

Certifying HUMS for engine operations

In a parallel activity, another DSTO researcher Graham Forsyth was tasked by the Director General Technical Airworthiness - Australian Defence Force (DGTA - ADF) to carry out certification of the Health and Usage Monitoring System (HUMS) component of the engine monitoring system, to validate its accuracy and for certification purposes.

Forsyth's work uncovered many other features of this system, which he found could be used to not only record usage – its nominal function – but also record what are known as trend engine parameters that enable forecasting of engine hot section usage rates and remaining engine life.

Both the propeller balancing and engine monitoring activities DSTO has investigated are being merged into an enhanced ground station engine monitoring and trending system, of which the propeller balance capability will be the first component to see routine service early in 2006.

Nearing the age of **superconductors at sea**

DSTO is working with superconducting materials that offer significant performance enhancements for undersea minesweeping systems of the future.

Dr Ken White and Frank Difrancesco working with superconducting coil.

One advantage the research aims to exploit is the fact that magnetic fields of superconducting coils can be turned off to avert interference with the instruments of a ship or aircraft transporting them. A superconducting minesweeping system can conceivably also be made within size and weight limits that provide air, sea and road transportation flexibility.

These logistical considerations are particularly important in scenarios involving amphibious landings where the minesweeping system needs to be carried on a forward-deployed vessel for use immediately before or during the landing operation.

Amazing superconducting materials

The key advantage of a superconducting minesweeping system is in the coil that produces the magnetic field. The superconducting wire DSTO is using consists of a silver strand flattened into a tape that encases up to sixty filaments of a ceramic, $Bi_2Sr_2Ca_2Cu_3O_{10-x}$.

The ceramic compound, known as Bi-2223, is one of a class of high temperature superconductors that produce superconducting effects at more easily attainable temperatures than others. Some superconducting materials require temperatures only a few degrees above absolute zero (minus 273 degrees Celsius) necessitating the use of liquid helium, which is difficult to handle and expensive to produce.

DSTO researcher Dr Ken White explains, "Ceramics like Bi-2223 can be made to perform with readily available liquid nitrogen, which has a boiling point of 77 kelvins (minus 196 degrees Celsius). These ceramics are known to be very effective electrical insulators at room temperatures, but miraculously transform into superconductors when sufficiently cooled. A downside of ceramics, however, is that they are very brittle to work."

The property of superconduction means that a coil can continue to produce powerful magnetic fields virtually indefinitely with no electrical energy required to maintain this effect, provided the coil stays below the requisite temperature for superconduction. By comparison, conventional electro magnets require a constant electrical input to produce a magnetic field because energy is continually being lost in the form of heat through the effect of electrical resistance.

Devices using superconducting materials can therefore be made more powerful, more efficient, more compact and lighter than their conventional counterparts.

3-D computer mock-up of superconducting coil with core in torpedo housing.

DSTO's research program

DSTO is developing two demonstration systems:

The first involves a mild steel core system. The superconducting coil is surrounded by liquid nitrogen, with a mild steel core inserted in the middle of the coil. When a current is applied to the coil, the uniform magnetic field in the centre of the coil magnetises the core.

The coil and core will ultimately be housed in a torpedo shaped body for ease of deployment. The advantages of this system are that it will be variable in strength and air transportable. However, this system is magnetised only along its longitudinal axis.

The research so far has produced some experimental results and computer modelling of the magnetisation of the ferromagnetic core. Computer modelling done on the effect of changing the length of the ferromagnetic core from one metre to two metres shows that the magnetic flux density within the core almost triples in value. It is anticipated that a laboratory prototype can be produced in three years.

The second program will see the development of a substantially lighter, non-cored 3-axis system that would make use of stacks of pancake coils. In this orthogonal system, the coils (stacks of pancakes) are positioned at 90 degrees to each other, and a range of operating temperatures will be investigated to as low as 20 kelvins.

White says, "We plan to use a cryocooler (refrigerator) to cool the coils, contained inside a vessel insulated by a vacuum between layers of material with reflecting surfaces, very like the common thermos flask. As the temperature is lowered, the action of the Bi-2223 superconducting tape is enhanced, and much larger current loads and magnetic fields are achievable. With stronger magnetic fields being produced at these lower temperatures, the iron core is no longer necessary, and so the apparatus can be made much lighter."

The development of this prototype is expected to take four to five years.

Through an industry alliance between DSTO and ADI, Australia has established a niche role as a globally dominant developer and supplier of mine sweeping systems. The current research aims to maintain and enhance this leading role.

A brief history of superconductors

The Dutch physicist Heike Kamerlingh Onnes, working at the University of Leiden, successfully liquefied helium in 1908 which led to the discovery of superconductivity in mercury in 1911.

Over the subsequent decades, numerous superconducting materials were found, but the critical temperature at which the phenomenon occurred remained below 30K (-243°C).

After 1987, a range of exotic ceramic materials were found to display superconductivity at significantly higher temperatures, in particular, above the boiling point of liquid nitrogen 77K (-196°C). These materials are relatively inexpensive, abundant and comparatively easy to handle. Since then researchers around the globe have been exploring the properties of these superconducting materials, leading to the development of many products in widespread use today.

Opening the way for industrial applications was a second major breakthrough that saw the development of techniques for fabricating fragile superconducting ceramics into durable wire structures on a mass-production basis, achieving both greater robustness and lower unit cost. The products being developed include generator sets, electric motors, magnetic resonance imaging scanners, power backups and transmission lines.

Wayamba works well with unmanned partners

A series of trials were recently carried out using unmanned underwater and air vehicles to test their ability to work together as part of DSTO's Automation of the Battlespace Strategic Initiative.

DSTO's Unmanned Underwater Vehicle (UUV) Wayamba.

The exercises were undertaken last November in Port Phillip Bay under a RAN Mine Warfare Exercise (Dugong) to garner useful critical feedback from uniformed personnel on the relative benefits, strengths and current shortcomings of unmanned technologies for littoral mine warfare operations.

Organisations participating in addition to DSTO included the RAN, Nautronix, Sonartech Atlas, Tenix, and Aerosonde Pty Ltd.

The scenario being played out involved the conduct of surveillance missions to prepare for a possible amphibious assault on a remote littoral location. The operational conditions posited were that the RAN vessel carrying out the mission had to stand some distance offshore to avoid the possibility of revealing the area under consideration to the enemy.

Using unmanned craft, the task was to undertake preliminary surveys of potential landing sites, and once a particular site was selected, to carry out a more detailed survey of that site to determine its suitability. These surveys were required to be conducted covertly, with surveillance to include assessments of the landscape and environmental conditions beyond the beachhead.

The unmanned vehicles used in the trial included Wayamba, DSTO's experimental Unmanned Underwater Vehicle (UUV), and two Aerosonde Unmanned Aerial Vehicles (UAV); one for aerial surveillance operations, and the other acting as a mobile communications relay station.

The communication linkages

The command and control aspects of the operation for the UUV and UAVs were undertaken on board the RAN vessel MSA Bandicoot.

The facilities for the UAVs included control stations for the two aircraft, and a control and display system for a UAV-mounted surveillance camera. These systems were used to display mission data in real-time, with some also having replay capability.

Wayamba was controlled via the Sonartech Atlas Integrated Survey Sensor System (ISSS). The ISSS is a mission planning and display facility, incorporating data and sensor inputs from a range of sources, used to set the coordinates for a mission and view in real-time the path and attitude taken by the UUV.

DSTO researcher Roger Neill threw some light on the intricacies of the communications links involved in the exercise.

"When UUVs are submerged they are unable to directly receive radio frequency (RF) communications. To facilitate two-way contact between MSA Bandicoot and Wayamba while underwater, the Nautronix/DSTO gateway system Netsong was used. RF signals were relayed by a transceiver on board an Aerosonde UAV to a communications buoy, which in turn relayed them underwater to Wayamba in acoustic signal form. This system, using UAV link, proved to be very effective in passing command signals and low data rate streams between the UUV and the command vessel."

"When Wayamba was surfaced, communications between the command ship and the submersible were carried out via RF transmissions, again using the UAV as a relay link, making possible much faster rates of data transfer."

In addition to the communications capability afforded by Netsong, a complementary underwater navigation system known as Navsong was used to supplement the inertial navigation system on board Wayamba. Navsong is a Nautronix-developed underwater navigation system that will ultimately enable an UUV to lay its own self-calibrating navigation array. By operating both inertial and Navsong navigation systems simultaneously, Wayamba was able to navigate with good accuracy throughout the exercise.

The sequence of operations

The exercise was carried out as a series of vignettes.

The first stage involved planning a preliminary Rapid Environmental Assessment (REA) survey operation using ISSS and sending the waypoint data to Wayamba. The UUV carried out the mission, sending back data indicating its progress while underwater for display by the Sonartech Atlas system.

Wayamba was then instructed via Netsong and UAV link to surface and use the higher-bandwidth, RF-only link to send a detailed survey dataset for evaluation by the command ship.

For the next vignette, Wayamba was tasked to use high-definition sonar as its primary sensor as it undertook a mine countermeasures survey, once again communicating with the RAN vessel using Netsong.

A number of targets had been laid to represent a possible minefield. The objective was to collect and store snippets of sonar data for each of the mine-like contacts and to send the positions of the contacts to the command ship. Where a contact was deemed to be in a location of particular operational interest, the command ship could ask the UUV to undertake a 'reacquire and identify' mission to elicit further information on the properties of the detected contact.

The UUV navigated a reciprocating course along a block of seven parallel lines with high accuracy – known in the industry as 'mowing the lawn' – and at the end of the fourth track, a series of tight turns were undertaken to further investigate a mine-like object.

The two UAVs were operational throughout the exercise.

One acted as a communications link to relay information between Wayamba and MSA Bandicoot, enabling the Navy ship to operate with considerable freedom of manoeuvre while maintaining constant contact with the unmanned assets.

The other, carrying a stabilised pan-tilt-zoom video camera with automatic target tracking capabilities, undertook aerial surveillance, both to check on enemy presence in coordination with Wayamba's activities and to determine the suitability of potential landing sites being investigated as part of the exercise scenario.

The trial outcomes

While DSTO does not yet have fully functioning systems in all the areas involved, the exercise very successfully demonstrated an ability to coordinate command, control and communication activities between the manned and unmanned platforms. Ongoing DSTO activities aim to develop the systems to a level of maturity where the Navy can deploy and evaluate them with minimal need for DSTO to be directly involved at the operational level.

Commenting on the outcome of the trials from a Navy perspective, Captain Daryl Bates, Commander of the Australian Navy's Minewarfare and Clearance Diving Group, says, "The results are exciting. Advances in the technologies associated with unmanned vehicle operations will serve to enhance our existing and future mine countermeasure capabilities, and assist Navy in minimising risk to our people when undertaking our mission. The trial also demonstrated the strong linkages between Navy and DSTO, linkages that have developed over time and are reinforced through support for activities such as these for mutual benefit."

Using a combination of EO and IR sensors Unmanned Aerial Vehicles carry out surveillance, environmental assessment, mine warfare and intelligence operations. They also provide a radio relay between the control vessel and Wayamba via the acoustic communications buoys.

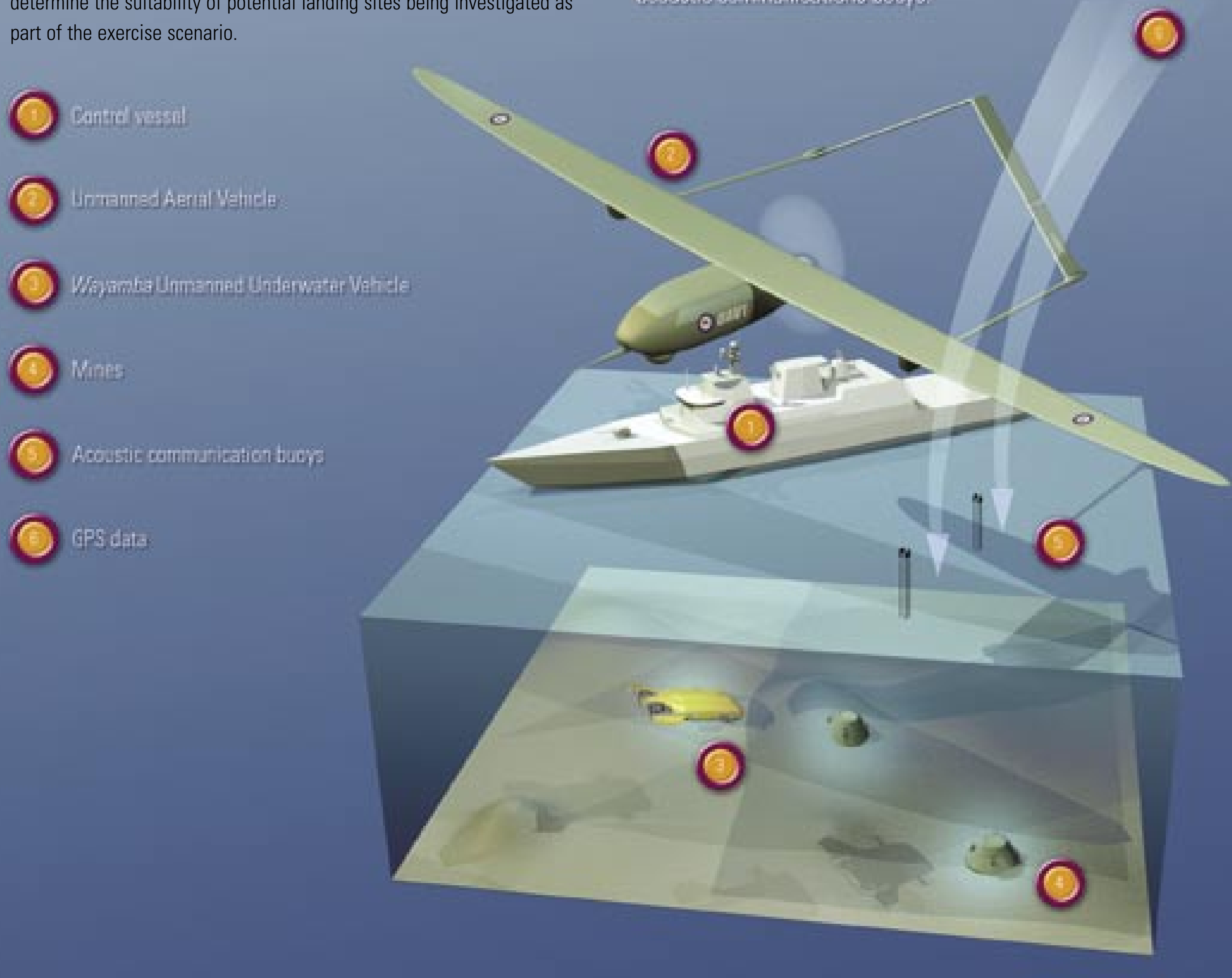
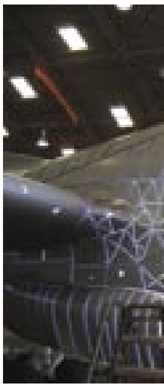


Photo portrait of Orion with millimetric accuracy

A photographic survey of the AP3 - C Orion was recently undertaken to produce a precise measure of its exterior to assist with research into the deployment of weapons, known as 'stores', that the aircraft can carry on wing pylons. The survey represents a first in Australia for an aircraft of this size.



The request to DSTO coming from the Defence Materiel Organisation was to perform analyses in the area of store loads, store separation, performance and handling. In order to meet this request, highly precise data on the geometric shape of the AP3-C aircraft was required.

A photogrammetry survey was proposed as the best means of obtaining the data, and Vision Metrology Services (VMS) Melbourne was tasked to carry out the work. An advantage they were able to bring to the project was an ability to overcome temperature variability problems arising when measuring objects in situ.

Maritime Patrol Systems Program Office (MPSPO) arranged for the availability of the aircraft from 92Wing. Aerostructures Australia, a Melbourne-based company that specializes in structural integrity engineering, was contracted to perform follow-on work on the development of Computational Fluid Dynamic (CFD) models.

Over the course of eleven days in November 2005, DSTO and 92Wing staff along with VMS and Aerostructures contractors, surveyed the whole aircraft shape.

The photogrammetry technology

The equipment being used included a single high-resolution intelligent digital camera (INCA), notebook computer, V-Stars software, and accessories; constituting a small portable kit.

This system is capable of producing 3-D coordinate point data to an accuracy of 1:120,000, meaning that for a 10-metre sized object, features less than a tenth of a millimeter can be accurately represented.

By attaching high-contrast retro-reflective target points to the object being measured, and then imaging the object from several different positions, the spatial positions of these target points can be determined by triangulation. This data is used to create a three dimensional model.

DSTO researcher Andrew Snowden explains the benefits of this approach.

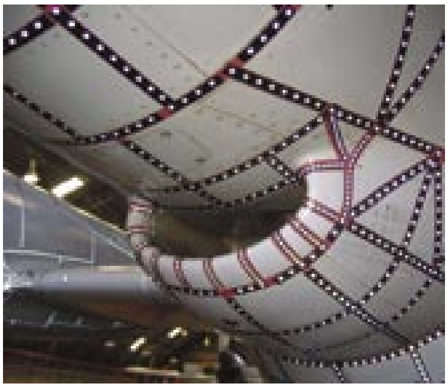
"Photogrammetry is ideal for measuring large objects such as the Orion. Besides being extremely portable, the system provides data in a format already compatible with existing modelling tools."

"As well as being a very cost-effective measurement method, the photogrammetry process also minimises disruption to aircraft operations. We were able to go in during maintenance work time and collect our data while the Orion was being worked on. That went a long way towards getting the RAAF to agree to the process."

The measurement process

The process began with the attachment of red adhesive tape to the Orion to protect the paint finish, with strips of black tape containing retro-reflective targets laid down over the red tape.

Once the target icons were in place, a series of photos was taken from a range of viewpoints, concentrating on specific areas. The photographic process was broken up into sections; forward fuselage and cockpit, mid and aft fuselage, empennage, wing, wing and fuselage intersection, and finally engine nacelles.



Areas of constant section, like the mid fuselage with a simple circular cross-section, were simplified by defining only two sections, one at each end of the constant surface. Other areas of moderate curvature, like the forward and aft fuselage sections, could be broken up into smaller panel sizes, usually by using the aircraft's own rivet lines as a guide. Areas of high curvature in three dimensions, like the engine nacelles, empennage-fuselage intersection and wing-fuselage intersection, had to be broken up into much smaller pieces, usually triangular sections, in order to better capture the surface curvature in each direction.

In addition to measurement of the complete clean aircraft, the geometry data being gathered included control surface deflections, flap configurations, bomb bay deployment and installed wing store pylons.

Approximately 2,000 photos were taken. As each section was photographed, the images were processed using the V-Stars software to convert the illuminated targets into point data. The coded targets from each section were used to align each data set into the same coordinate system.

The geometrical data is already being used by MPSPO to verify the design of a maintenance platform for the Orion aircraft. DSTO plans to use the data to conduct a detailed CFD and wind tunnel analyses together with the Aerospace Operational Support Group at RAAF Edinburgh. The work will provide direct support for studies of store release trajectories as well as aerodynamic and flight dynamic studies for external modifications of the aircraft.

Photogrammetry retro-reflective target tape on PC-3 Orion.

Photogrammetry

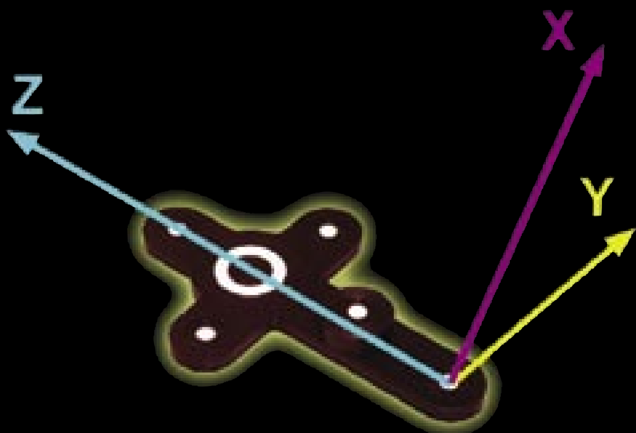
Photogrammetry is a 3-D coordinate measurement system that uses photographs as the fundamental medium for measurement.

The underlying principle is triangulation; by taking photos from at least two different positions, lines of sight can be built up from each position to points on the object. While only two photos theoretically are required to build a 3-dimensional object, inescapable errors in the procedure mean that several photos are necessary in practice.

A 3-D image is built up as a series of points established by mathematically intersecting converging lines in space. The process of triangulation requires establishing both the position and angular orientation of the camera for every picture. The camera location is determined by specially coded targets at known positions attached to the object.

The targets each have a unique pattern of squares to pinpoint the camera location and orientation. Their reflective surfaces make them easily readable with a low powered flash, and also mean that the exposure time can be very small, resulting in a relatively dark background image to make the targets stand out.

To obtain scaled measurements, at least one known distance is required. This is usually supplied by a scale bar, a precision tooled instrument that can be adjusted to a range of lengths. Reflective targets on each end of the scale bar provide a reference length for the processing software.



Sharing information for **better war fighting**

DSTO is collaborating with US Army researchers to investigate ways of sharing and exploiting tactical information that will enhance the situational awareness of tactical units.

For Army personnel engaging an enemy from above in a helicopter or on the ground, the sharing of tactical information between commanders and their troops is vital to success. Similarly, for Australian Defence Force personnel participating in joint operations, the sharing of information between Coalition partners is also essential.

During August and September 2005, DSTO participated in the operational phase of the US Army's C4ISR on the Move (C4ISR OTM) experiment, a major annual US Army experiment held at Fort Dix, New Jersey, to explore the impact of C4ISR technologies on the force effectiveness of platoon-sized units within the Brigade Combat Team (BCT).

The issues under assessment included: how the quality of information at the platoon level was impacted by the sensor mix, the fusion processes, and the information management protocols employed; what battle command interface functionality and decision aids were essential at the company and platoon echelons; what actions were required to enable information flow between the experimental force and joint and multi-national entities; and how the information made available through the implemented architecture impacted the decision-making and mission-execution at the platoon level.

A range of Australian and US C4ISR technologies were employed in a realistic, free-play operational environment to explore issues relevant to the flow of information throughout the BCT experimental force.

DSTO's Aerosonde DEWSAT system

DSTO's participation in the C4ISR OTM experiment involved the integration of its Aerosonde UAV-based Distributed Electronic Warfare Situational Awareness and Targeting (DEWSAT) system into the US C4ISR OTM test bed for evaluation and comparison with other systems brought to the experiment.

The DEWSAT sensing technologies comprised miniaturised Electronic Support (ES) sensors on board multiple UAVs that were used to passively detect, identify, and approximately locate target radars in a complex land environment. The information was then used to cue another UAV carrying a stabilised Pan-Tilt-Zoom (PTZ) Electro-Optic (EO) video payload, which would over-fly, accurately locate, and visually identify the camouflaged targets.

Information generated by Australian systems about detected radar sites and associated threats, including live imagery, video 'chips' (still images), and derived electronic surveillance, was made available across the US Army command echelons from brigade to the platoon level.

This information delivery was achieved by integrating DSTO's system with the US Command & Control system called Sensor Exploitation & Management System (SEAMS) and through it to Force XXI Battle Command Brigade-and-Below (FBCB2). Australian image products were displayed on the FBCB2 screen mounted in the Troop Commander's vehicle, and were also available on the Platoon Leaders' data tablets.

Soldier with Personal Digital Assistant (PDA) showing image transmitted from UAV.

DSTO's wireless network

As another line of investigation additional to the core C4ISR OTM experiment, DSTO also took its own wireless 2.4GHz network to Fort Dix to enable the demonstration of dissemination concepts.

Participants were shown how video and video chips could be provided to dismounted users with a handheld Personal Digital Assistant (PDA), with the PDA also being used to task a UAV to provide imagery of a specific location.

The ability of the DSTO system to get Aerosonde imagery to – and allow control from – all US echelons simultaneously (brigade down to platoon) was a noteworthy outcome.

The key to the levels of Coalition interoperability achieved by DSTO during the trials was the adoption of a services oriented architecture to integrate loosely coupled systems.

Opportunities and outcomes

The C4ISR OTM experiment was observed by Australian Army personnel. According to DSTO researcher Dr Tony Lindsay, "The presence of Army provided an opportunity for them to see what we're trying to achieve, and also how we're trying to leverage the research into US experiments and access their projects."

Lt Col Kath Stewart briefing the US Secretary of Army, Mr Francis Harvey, and the Director of CERDEC, Mr Gary Martin.

"As well as learning how to integrate our technologies with coalition partners, DSTO is keen to experiment with these technologies in an Australian environment to help shape their employment by the ADF through exercises such as Rainbow Serpent," he says.

Commenting on the value of the overall exercise, DSTO's Deputy Chief Defence Scientist (Systems), Dr Nanda Nandagopal, said, "C4ISR OTM gave us an opportunity to work with an important Coalition partner and look at technologies for improving the situational awareness of tactical units operating in a Coalition environment. By demonstrating capabilities and sharing ideas during experiments like C4ISR OTM, we can more effectively work with our partners to build technologies to support integrated Coalition tactical operations."

Defeating the pong in the deep

Lyn Fletcher with biofilter blanket.

As one of the more unusual research projects DSTO has been asked to undertake for Australia's armed forces, the RAN recently requested a study of ways to neutralise odour from stored waste in Australia's submarine fleet.

The problem arises as a result of RAN's standard operating procedures, for tactical as well as environmental reasons, to store waste on board a boat during a voyage, creating a significant air quality issue when boats remain submerged for weeks on end.

The trial came about following discussions between DSTO researcher Lyn Fletcher and submariners during a review of possible future improvements to solid and liquid waste management on submarines.

Fletcher talked to a number of submariners to get an understanding of what their current practices were and what issues they had currently. "The smell from the stored garbage came up a number of times," she says. "It was during this that I was told about the unpleasant odour, and that it can waft up to the accommodation spaces above."

"Since it would be some time before any major improvements could be made to the submarines' current waste management and handling equipment, I came up with what I thought might be a solution to reduce the problem in the interim."

Looking to landfill for answers

Fletcher knew that many landfill operators were increasingly getting complaints about odour from residents living nearby, as a result of which, odour absorbing blankets had been developed to stem the stink at source.

She selected an Italian manufactured blanket, Ambientalia, marketed by an Australian distributor. It consists of open cell foam completely impregnated with activated carbon, reinforced with a bottom layer of glass fibre matting to give strength while maintaining flexibility.

The blanket was initially tested at DSTO for ruggedness and odour reduction performance. The blankets were also tested for smoke and fire resistance to confirm that they were safe to use on a submarine. Following these tests the blanket was approved for a trial on a submarine.

The on-boat trial

HMAS Sheean, about to depart for a long deployment, was chosen as the boat to test the Ambietalia biofilter blanket at sea under typical operational conditions.

The trial was carried out over a period of 48 days, during which the submariners were asked to fully cover the garbage with a biofilter blanket and rate the perceived reduction in odour. To assist their assessments, they were asked to remove the blankets occasionally during the trial so they could judge the reduction in odour more accurately.

Their initial attempts to stifle the odour using only one blanket proved difficult because this barely provided adequate coverage: even so, they attained a perceived odour reduction of 75% - 80%. By using multiple blankets, odour reduction levels improved to 90% - 95%. By the 48th day using the same blankets, the perceived odour reduction was still an impressive 80% - 90%.

Overall, the trial found that the blankets were very sturdy and did significantly ameliorate the odour problem. A recommendation for improvement was that the blanket size be doubled.

One firmly convinced observer of these trials is the Commanding Officer of HMAS Sheean, who officially recommended 'that the biofilter blanket be immediately employed on all submarines'.

HMAS Sydney fitted with signature reduction materials

Two DSTO signature reduction systems were recently installed on HMAS Sydney, effective for radio frequency (RF) and infrared (IR) signals.

A demonstrator panel of structural radar absorbing material (SRAM) was installed to demonstrate the durability, robustness and RAM-stability in an active ship environment over an extended period. The fiberglass-based SRAM will increase the design options to reduce ship radar cross section profiles in future ship builds and retrofits.

The infrared system was temporarily installed to the stack as a prototype to demonstrate the concept, the robustness and the ease of assembly, fit and removal. The stack reduction system reduces the IR signature of the ship, thereby reducing the lock-on range of an IR guided anti-ship missile. Full scale measurements are scheduled to be carried out in 2006 to verify the performance of the system.

Australian industry was involved in all aspects of manufacturing the prototype systems, and will be responsible for designing and manufacturing the systems used for full scale trials. Industry collaboration with the treatment of the glass-fibre raw material for the SRAM enabled the delivery of this strategic material at a fraction of the cost of similar imported product.

New Centre of Expertise boosts Australian strategic radar research

DSTO and the University of Adelaide recently signed an agreement to establish the Centre of Expertise in Phased Array and Microwave Radar Systems (CEPAMR) located within the University's School of Electrical and Electronic Engineering.

The new centre will underpin efforts by DSTO and Australian industry to tackle practical engineering problems associated with the design, development and integration of the next generation phased array systems.

Research outputs from the centre are expected to have significant long term benefits for defence applications, including development of phased array radars on airborne platforms and radars for future naval platforms, emerging ballistic missile defence surveillance and tracking requirements, and a potential indigenous air defence radar system for Army applications.

Additionally, the Centre will support growing national requirements for radio frequency engineers within DSTO, industry and the civilian commercial sector.

DSTO scientist Dr Bevan Bates has been appointed Director of CEPAMR. This is the second Centre of Expertise established by DSTO and the University, with the two organisations having set up a Centre of Expertise in Photonics in 2004.

DSTO turntable opens for business

A facility for measuring radar signature data for various Australian Defence Force air and land platforms has been built at the RAAF Edinburgh airbase, adjacent to DSTO's Edinburgh site.

The aircraft signature turntable (AST), in conjunction with mobile instrumentation radars, provides a Radar Cross Section (RCS) measurement capability with increased speed, accuracy, resolution, and repeatability over existing methods available. This higher quality data will be used to assess vulnerability and develop countermeasure programs that will improve levels of survivability for ADF platforms.

The turntable has a diameter of 17 meters with a design load capability of 85 tonnes. It has been designed to carry aircraft such as F/A-18, F-111, B737 (Wedgetail), C130 and others, as well as land-based assets such as tanks and armoured personnel carriers. It is believed to be the largest turntable of its type in the Southern Hemisphere.

CALENDAR

28 - 30 Mar 2006	Defence Experimentation Symposium Australian National Maritime Museum Sydney Tel: 08 8259 5205 Email: paul.gaertner@dsto.defence.gov.au
4 - 5 May 2006	TTCP Human Systems Integration Symposium R1 Theatrette, Russell, ACT Tel: +61 3 9626 8618 Email: symposium.hsi@dsto.defence.gov.au
27 - 29 Jun 2006	UDT Europe 2006 Congress Centrum Hamburg, Germany http://www.udt-europe.com/
3 - 5 Jul 2006	Optical Communication Systems and Networks Banff, Alberta, Canada http://www.iasted.org/conferences/2006/Banff/ocsn.htm
10 - 14 Jul 2006	Electrical Transport and Optical Properties of Inhomogeneous Media (ETOPIM) Cockle Bay Wharf, Darling Harbour, Sydney Email: stuart.anderson@dsto.defence.gov.au
19 - 25 Jul 2006	Complex Adaptive Systems Symposium 2006 Adelaide Tel: 08 8259 6771 http://www.dsto.defence.gov.au/4197/
24 - 28 Jul 2006	Science of Autonomy Symposium 2006 Adelaide Tel: 08 8259 http://www.dsto.defence.gov.au/4198/
24 - 27 Oct 2006	Land Warfare Conference 2006 Brisbane Tel: 08 8259 5455 Email: lwcc@dsto.defence.gov.au
20 Mar 2007	HUMS 2007 – Health and Usage Monitoring Conference Melbourne http://www.dsto.defence.gov.au/3632/

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